



# FOREST HEALTH PROTECTION

## Pacific Southwest Region

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### **Evaluation of Insect and Disease Incidence on the Big Grizzly Project, Georgetown Ranger District Eldorado National Forest**

**Summary of recommendations.** *Forest Health Protection, South Sierra Shared Service Area was requested to look at management plans for the Big Grizzly Project to determine if these plans incorporated appropriate forest health measures. In this report the forest diseases found in the area of the Big Grizzly project are briefly summarized and then comments are offered on some of the measures that have to do with minimizing the impact of *Heterobasidion annosum*, the most important disease found in the project. While making field evaluations of proposed areas, we saw nothing that would substantially contradict any of the underlying principles of this project. We strongly support blanket application of the Regional Policy on the use of a borate treatment in all proposed areas except for pine plantations. Based on the biology of *Annosum* root disease, we suggest the following recommendation concerning stand improvements with gaps treatment: that the size of disease pockets is dictated by the disease and not by any set acreage limit. We suggest the pocket size be expanded by two trees to include asymptomatic edge (host ) tree and that the margins of the pockets be deep ripped to break roots grafts through which the disease would otherwise continue to spread.*

### **Introduction**

Forest Health Protection (FHP), South Sierra Shared Service Area personnel were invited by Dana Walsh (Forester, Georgetown Ranger District) to evaluate forest health conditions and provide management recommendations for the Big Grizzly Fuels Reduction and Forest Health project that is scheduled for implementation in summer 2009. FHP field surveys occurred on August and October 2008 to assess current insect and disease conditions in stands proposed for treatment and provide management recommendations to improve forest health. FHP was specifically asked to emphasize on identified annosus root disease (*Heterobasidion annosum*) centers. This report summarizes our field evaluations and discusses management options available to mitigate damage caused by the biological agents found in the project area. .



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The primary objective of the Big Grizzly project is to improve stand vigor and resistance to disease and insect-related damage while reducing hazardous fuel loadings and enhancing wildlife habitat. The management proposed to meet these objectives include: mastication followed up with herbicide, treatments in pine plantations, sanitation removal and planting in root disease-infected areas, and thinning from below in general forested areas.

Thinning these densely stocked stands will reduce residual tree susceptibility to insect outbreaks and stand-replacing wildfire events. Targeting suppressed and weakened trees for removal will help reduce the amount of host available for bark beetle and disease colonization and reproduction. Annosus root disease centers are proposed for selective removal of infected fir hosts, followed by planting non-host pine species. Brush and smaller diameter trees in plantations will be thinned to accelerate growth and stand development. Treatments are expected to improve tree vigor and increase stand resistance, against insect and diseases, and also predicted warming trends.

### **Observations**

The Big Grizzly project is located in the northeastern sections (Township 13 N, Range 12 East, Sections 13 south, 14, 16, 22, 24; Township 13 n, Range 13 E, Sections 1, 2, 10-15, 18, 21-23, 26-34; Township 13 N, Range 14 E, Section 36) of the district. It encompasses most of the federal land around Nevada Point and Devils Peak. The project covers approximately 4500 acres and ranges from 4700-5200 feet in elevation. The proposed sections for treatment are intermixed among federal lands and private inholdings. No surveys were conducted in wildlife Protected Activity Centers (PACs) within the larger area of the Big Grizzly project as no treatments are planned for these units.

The condition classes of proposed treatment areas deemed outside their historic range of variability. Shade-tolerant species dominated stand compositions due to past selective logging of pines combined with fire exclusion policies. Forests in this area were historically composed of large-diameter ponderosa pines widely spaced with open canopies maintained by frequent low-intensity wildfires. Based on our survey, stands were primarily composed of 50% white fir, 30% incense cedar, and 10% black oak, ponderosa pine, or Douglas-fir species. Remnant “legacy” ponderosa pines were scattered surrounded by dense thickets of white fir or incense cedars of various diameters. Stands were fairly dense with basal areas ranging from 200-350 square feet per acre for natural stands. Insect and disease conditions varied by treatment unit and are discussed subsequently by agent and treatment designation.

### **Discussion of White Fir Dwarf Mistletoe and *Cytospora* Infection**

Throughout the project area, mature white firs were found to have extensive white fir dwarf mistletoe (*Arceuthobium abieninum*) infection in association with *Cytospora abietis* cankers. Dwarf mistletoe plants can cause irregular branch growth (“witches brooms”) on infected hosts. This abnormal growth is common on infected pine species; however, white fir dwarf mistletoe induces witches’-brooms rarely and only in old infections (Filip *et. al*, 2000). Specifically, two kinds of other brooms are often confused with dwarf mistletoe infection and were found on fir in

surveyed areas. One is caused by the rust fungus *Melampsorella caryophyllacearum* (Filip *et al*, 2000) and the other is caused by the true (leafy) mistletoe *Phoradendron pauciflorum* (Geils *et al*, 2002). As white fir dwarf mistletoe does not commonly produce brooms, the intensity of infection is often underestimated using the Hawksworth rating system on true fir (especially white fir). It is possible to use *Cytospora abietis* infections as a surrogate for *Arceuthobium abieninum* infestations (see Figure 1). The slight swellings and the root wounds caused by the mistletoe plants become the entry points for the branch killing *Cytospora* fungus (Scharpf, 1969). As the mistletoe plant is an obligate parasite it is long dead before the *Cytospora* fungus has killed the branch. The *Cytospora* fungus is a weak pathogen and although it might be present it will not kill branches unless they have been previously wounded by the dwarf mistletoe (Filip *et al*, 1979).



**Figure 1.** *Cytospora* killed limbs on a white fir – limbs most likely initially infected with dwarf mistletoe.

### **Observations and Management Considerations for White Fir Dwarf Mistletoe and *Cytospora* Infection**

Although, as described above, the lack of brooms produced by the white fir dwarf mistletoe makes an accurate Hawksworth Dwarf Mistletoe Rating (DMR) of closed canopy white fir problematic. Based upon our observations mistletoe infestations appeared to increase with tree size (a loose surrogate for age) and proximity to other heavily infected hosts. Direct treatment is not recommended for the white fir dwarf mistletoe as no direct control techniques are effective in this situation. However, indirect treatments can reduce subsequent spread of the mistletoe

infection by promoting species diversity and targeting infected trees for removal wherever practical. Promoting species diversity will reduce the risk of subsequent mistletoe infection spread since white fir dwarf mistletoe is host-specific and seeds dispersed from parent plants cannot infect any other species. Targeting severely infected trees for removal will reduce the number of infected hosts contributing toward seed dispersal in a stand.

### **Observations of Pine plantations proposed for treatment**

In our surveys of the pine plantations, no annosum root disease signs or symptoms were observed. However, we immediately found a healthy, fully-developed, spore-producing *H. annosum* conk in the first, and nearly every other excavated white fir *stump*. Our observations indicate that the fungus was ubiquitous and found throughout the entire project area, but is restricted to white fir. No evidence of annosum root disease in pine or incense cedar potential hosts was detected. As it is the pine type that kills both pines and incense cedar (Schmidt *et al* 2000), it is safe to assume that the Big Grizzly project area is colonized by only one of the two biological species, and the pines and incense cedar trees are not hosts to the Spruce type (S-type) Annosus disease. We did not find annosum in Douglas-fir stumps – although this species is known to be a susceptible host for S-type Annosus. All Annosus conks we found were formed inside white fir stumps. Schmidt *et al* (2000) report that Douglas-fir in California is not seriously impacted by the “S” type, and we have observed that this is specifically the case on the Eldorado National Forest.<sup>1</sup>

Plantations were incredibly dense and stocking control is needed to reduce competition between trees and the understory brush vegetation. Walking through these areas was difficult as tree crowns overlapped and *Ceanothus* brush was insurmountable (see Figure 2). While basal areas were only about 220 ft<sup>2</sup> on average, large brush engulfed the lower half of trees and filled in any openings. Overstocking, vegetation density, and pole-sized (>9 inches) stem diameters combined increase the risk of western pine beetle (*Dendroctonus brevicomis*) and pine engraver beetles (*Ips* species)-related mortality, as well as catastrophic wildfire. As Pine type (P-type) Annosum was not present in plantations, the most immediate forest health issue was high levels of competition. Mastication of smaller diameter conifers and brush vegetation will enhance residual tree access to water, light, nutrients, and overall growing space to increase vigor and growth. If left untreated, incremental growth will continue to exacerbate existing competition, making trees highly susceptible to bark beetle attacks.

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<sup>1</sup> Before any discussion can be made of the levels of *Heterobasidion annosum* induced mortality in the other two treatment areas can be considered, the significance of the failure to detect any annosum caused mortality in the pine plantations must be explained. But even before this can be made a taxonomic clarification is in order. In the older literature *H. annosum* was known as *Fomes annosus* and it was the fungus that caused annosus root rot, when the name got changed from *F. annosus* to *H. annosum* most older workers kept the old common name annosus root rot (e.g. Schmitt *et al*, 2000) while other researchers switched the common name to annosum root rot. In truth, as these are only common names either is acceptable and for the remainder of this report we will follow Tainter and Baker (1996) and call the condition annosum root disease.

The seminal study on the genetics of *Heterobasidion annosum* were conducted in Finland by Korhonen (1978) who divided the fungus into 2 types or mating groups, one he called the “P” type and the other the “S” type. The “P” type was recovered from pines, predominately Scots pine (*Pinus sylvestris*) and the “S” type was recovered from Norway spruce (*Picea abies*). Hence the “P” type is the Pine type and the “S” type is the Spruce type. This typing has held up in North America and the “P” type is a pathogen of Pines (Plus incense cedar) and the “S” type is a pathogen of true firs (Chase, 1989)



**Figure 2.** Representation of pine plantation conditions showing dense brush vegetation in the understory.

### **Observations and Discussion of areas proposed for “Stand improvement with /gaps” treatment**

The following passage taken from the 2008 Scoping Notice is a succinct description of the areas proposed for a “Stand improvement with /gaps” treatment:

“Current stands are dominated by shade-tolerant, drought- and fire-intolerant species (white fir, incense cedar, and Douglas-fir).... some stands are already experiencing high levels of mortality due to disease and insect activity. Although some of the stands in the project have been thinned and salvage-logged in the past, the dominant white fir stands are expected to continue to decrease in health and vigor over time due to Annosus root rot. These stands will continue moving farther from desired future conditions over time as high levels of mortality decreased canopy cover, stocking and growth at a stand level.”

In most of these areas, stand composition was characteristically dominated by mature white fir (>80%) with varying degrees of decline. Annosum root disease fruiting bodies or xylem delamination decay were consistently identified from older cut stumps in the center of openings (see Figure 3)<sup>2</sup>. Spread and size of Annosum infection in the stand were estimated from the extent of mortality radiating from stumps in the presumed center; however, most centers or perimeters could not be determined with much certainty. Hallmarks of centers contained numerous standing dead snags (see Figures 4a, 4b, and 4c), and windthrown spars which displayed the characteristic delamination along growth rings (see Figure 5). No pine or cedar stumps were found with Annosum.

Some aspects of the biology of *Heterobasidion annosum* that are relevant to the Big Grizzly Project should be discussed before management can be discussed.

<sup>2</sup> (There is another rot that causes a delamination of fir stumps. The laminated root rot fungus, *Phellinus weirii* (Nelson *et al*, 1981). The delaminations caused by the two fungi are different and *P. weirii* is extremely rare south of the Oregon border



**Figure 3.** *H. annosum* conk removed from an old fir stump. The conk has been turned over to expose the white pore layer. The arrows mark the gap through which the spores would have escaped from the cavity below.



**Figure 4a (left) and 4b (below).** Typical infection center characterized by the large amount of laminated rotted fir on the forest floor, and windthrown trees with basal delamination decay, surrounded by zones of progressively taller spars towards the periphery which is marked ring of declining trees.





**Figure 4c.** Looking outward from an infection center to the margin of asymptomatic trees. NOTE: Released incense cedar in the foreground and manzanita brush responded to increased light reaching the forest floor.



**Figure 5.** Close-up of a fallen white fir, initially killed by *H. annosum*. NOTE: Delaminated decay of the xylem, characteristic of this fungus.

Two ways that *Heterobasidion annosum* can spread: wind blown spores, or by growing down the root system of one tree, through a root graft and into the root system of an adjacent tree. Microscopic windblown spores contain only the minutest amounts of reserves; thus, when spores disseminate, the vast majority of them die. A small percentage of spores will land on a nearby stumps or open wounds on host trees. Only those spores that land on a freshly cut stumps germinate as new infection centers. In the context of the Big Grizzly project, spores can be windblown throughout all areas of the project and beyond. Therefore, mitigation efforts aimed at reducing spread of the fungus by spores must be applied equally to all areas that undergo treatment. However, areas with non-host trees of S-type Annosum, such as those that are predominantly pine stands, are the only places where prevention treatment is unnecessary.

Fungal spread by mycelial growth along underground root systems explains why infection appears in pockets, and why pockets are typically located in pure white fir stands. Disease spread by infection from root grafts will begin at the extremities of the root system and will slowly grow towards the root crown. Thus a tree can be infected for long time before it becomes symptomatic of infection. If an infected fir is growing near another fir there is a high probability of the two trees being root grafted. If so, the fungus spreads from one tree to the next, thus expanding the root-rot pocket underground.

For a root rot fungus the “below-ground landscape” is more important than “above-ground landscape.” If root disease centers are fairly well delineated and root grafts at the boundaries could be severed, underground disease spread could be mitigated. Of the two root rot fungi, *Armillaria* has been more extensively studied than *Annosum*. As these two root rot fungi have many characteristics in common, and methods for mitigating *Armillaria* impact are more fully developed than methods for mitigating *Annosum*. Oregon State University’s Professor Lewis F. Roth (1914-2009) investigated practical methods of disrupting below ground landscape of *Armillaria* root rot fungus. Because *Armillaria* fungus does not spread from tree to tree by root grafts but rather by root-like rhizomorphs, it is the more difficult fungus to limit. In Roth *et al* (1977) they outlined marking guidelines to combine commercial thinning and the control of *Armillaria* root rot. In this paper a diagram is provided of a typical *Armillaria* root rot center – similar to many observed in the Big Grizzly project area. By extrapolation from Roth *et al* (1977), once estimated boundaries of *Annosum* infection pockets have been marked, the margins should be expanded outward to the *second* asymptomatic host tree. It is assumed that the margin trees are also infected and thereby should be included in treatments for type conversions. As such, root disease treatment pockets may be larger than anticipated but should be considered if treatments are to be effective for the long-term. Deep ripping around presumed boundaries (using the kind of equipment described by Hagle and Shaw (1991), may help contain the disease. Root damage can be minimized by keeping ripping at least 10 feet away from root collar of residual trees. Ripping should be done on a line half way between the last taken and the first leave tree beyond the pocket boundary. Since incense cedar and black oak are immune to S-type *Annosum* fungus that only infects firs, it is recommended retaining all advanced regeneration, saplings and pole-sized cedars and oaks within disease pockets.

### **Legacy trees within the Big Grizzly Project**

During surveys, we occasionally encountered a “Legacy” ponderosa pine (typically pines greater than 40 inches diameter-at-breast height). In most cases, pines were surrounded by thickets of incense cedar and white fir (see Figures 6a & 6b). To improve resource allocation for the legacy pine, all understory within the drip line of legacy trees out towards the bole of the nearest dominant tree should be removed. The water demands due to overcrowding place increased water stress on legacy trees, making them more susceptible to bark beetles or other damaging agents.



**Figures 6a (left) and 6b (right).** Legacy trees surrounded by thickets of developing understory, creating water stress on Legacy trees making them more susceptible to insects and disease.

### **Observations of Thin-from-Below treatment areas**

In areas proposed to be thinned-from-below, *Annosum* conks were almost as prevalent as in the areas proposed for stand improvement with gaps. And yet only one site in the thin from below areas was observed with an annosum root disease pocket. The species diversity in the thin from below areas reduced the number of fir to fir root grafts and reduced the probability of disease pockets developing. *H. annosum* conks were frequently found immediately outside of units in nearby fir stumps, and thus the airborne spore loading may well be high in both treatment areas. It was commonly found that in heterogeneous stands, infected stumps were naturally isolated – surrounding trees were all non-hosts, and nearby live firs displayed no symptoms. Infected stumps will continue to produce spores, but potential for new infection centers will be reduced since hosts will be limited. However, application of an approved borate treatment immediate after thinning is essential to provide protection to, dispersed, freshly cut fir stumps, which are still susceptible to infection from airborne spores. .

### **General Discussion**

Based on assessment of ground observations and surveys, FHP determined that the high incidence of annosum root disease centers in the project area warrant significant treatments to mitigate future white fir mortality. The current conditions of infected natural stands are such that white fir present will continue to deteriorate, resulting in stagnant nonproductive forests. Since seed sources and optimum conditions for pine establishment are limited in disease centers, most stands will continue to move further away from desired future conditions. Current high stand densities also prevent new pine and hardwood reestablishment, while also increasing the risk for catastrophic wildfire. Healthy forests require some levels of native insect and disease activity; however, past land management in the area has altered conditions to favor large scale disturbances rather than small. The Big Grizzly project proposes treatments that will reverse trends and move project areas back towards historic healthier conditions. If natural stands and plantations remain untreated, bark beetles will most likely infest and cause unacceptable losses

that may interfere with management objectives. Appropriate vegetation management will significantly reduce and prevent predisposing factors that incite insect or disease introduction.

Mistletoe treatments were not specifically addressed in the marking guidelines, but should be included when rating for defects. While there is some uncertainty of the significance of mistletoe on firs, whether true or dwarf mistletoe, trees that show obvious symptoms of infection (branch brooming, *Cytospora* flagging, poor crown development, etc.) should be selected against. While true (“leafy”) mistletoes are photosynthetic, they are still water parasites whereas dwarf mistletoes are truly parasitic and contribute to both water and nutrient stress.

Mitigating factors that predispose trees to bark and engraver beetle attacks also increase tree resiliency against other damaging agents. Marking guidelines encourage thinning stands to stocking levels that are sustainable and productive. The intent is to create and maintain growing conditions that promote tree growth and vigor while reducing susceptibility of bark beetle attacks. Residual trees will greatly benefit from decreased competition for water and nutrients.

Proposed pine plantations are approximately twenty years old, and require thinning strategies to release trees and improve growth. Target basal areas of 80 -120 square feet per acre were found to be appropriate treatment guidelines that significantly reduced the potential for bark beetle attack in pine stands (Schmid *et al.* 1994). Proper treatment of resulting pine slash should prevent subsequent infestation of the residual trees, from populations of engraver beetles that would otherwise have developed in the slash (Schultz and Bedard 1987).

Fir engraver (*Scolytus ventralis*) is the main bark beetle known to attack true fir, but was not determined to be a primary mortality agent of white fir the Big Grizzly project area. Fir engraver typically attack trees already predisposed by disease or other form of stress. In California, outbreaks of fir engraver typically coincide with periods of drought (Ferrell 1989). Ground surveys in natural stands did not find much incidence of fir engraver, except within annosum root disease pockets. While there are no recommended marking guidelines for dominant white fir habitats, trees will benefit from treatments that increase soil moisture by reducing inter-tree competition (Ferrell 1978). Proposed treatments that also reduce host species abundance and susceptible host availability are the best strategies for prevention.

The district had already developed appropriate marking criteria and residual stand conditions to achieve the best desired conditions for forest health. Summarized below are the main treatments that were proposed in the Scoping letter and the *General marking guidelines for Forest Health units* (Sept 1, 2008):

- Desired residual basal area (*in second growth stands*) is between 180-210 square feet per acre and percent canopy is 60% post treatment
- Selecting against trees with fair to poor vigor based on crown and bole conditions.
- Selecting against shade-intolerant species (white fir, incense cedar, Douglas-fir) in favor of hardwoods and pines.
- Where root disease is suspected, create larger openings from 1-2.5 acres in size by removing potentially infected white fir hosts. Replanting of pines in openings to increase stand diversity.

These generalized guidelines concur with many forest health recommendations to reduce tree and stand vulnerability to insect and disease infestations. However, we suggest that the openings not be given a specific acreage limits, but rather that the size be dictated by the size of the infection pockets. Current stand density index values exceed thresholds for bark beetle risk in pines (>230) and fir (>375) in the Eldorado National Forest. Reducing basal areas in second growth stands to 180-210 sq ft/acre should alleviate some inter-tree competition, and allow necessary resources to be redistributed. In pine plantations the basal area may have to be reduced further to prevent bark beetle attack.

FHP strongly supports suggested treatments proposed in the Scoping Letter for the Big Grizzly project. Treatment options should be effective to prevent *Annosum* root disease spread if: (1) underground host root-to-root contact is disrupted, and (2) new above-ground infection sites are protected (i.e. freshly cut fir stumps). Removing available hosts at the margins of existing disease pockets should mitigate root disease expansion. Because “P”-type strain of *H. annosum* in the Big Grizzly project area was undetected in FHP surveys, it is acceptable to forgo a borate treatment of the thinned pine plantations. Also, any fresh stumps in plantations will most likely be less than the required diameter for treatment. However, all fir stumps should be borate-treated in natural stands. Stumps should be thoroughly covered with chemical protectant, in accordance with Regional Office guidelines and no later than **four** hours after tree falling. For further information, please contact FHP for chemical application guidelines.

Please contact Forest Health Protection, South Sierra Shared Service Area if there are any questions or more information regarding these recommendations is needed.

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